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Davies, Peter S.E.; Graham, Simon M.; Maqungo, Sithombo; Harrison, William J.

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# Total joint replacement in sub-Saharan Africa: a systematic review

Peter SE Davies<sup>1</sup> , Simon M Graham<sup>2,3</sup>, Sithombo Maqungo<sup>4</sup> and William J Harrison<sup>5</sup>

## Abstract

Outcomes of arthroplasty in sub-Saharan Africa are not widely reported. To our knowledge, this systematic review is the first to explore this topic. Scopus, EMBASE, Medline and PubMed databases were searched, utilising MeSH headings and Boolean search strategies. All papers from South Africa were excluded. Twelve papers reporting 606 total hip replacements (THRs) and 763 total knee replacements (TKRs) were included. Avascular necrosis was the most common indication for THR, whereas osteoarthritis was the main indication for TKR. HIV prevalence of up to 33% was seen. Improvements were seen in patient-reported outcome measures in both THR and TKR. The dislocation rate in THR was 1.6%. The deep infection rate was 1.6% for TKRs and 0.5% for THRs. Positive results were reported, with comparable complications to high-income countries. However, there is likely to be significant reporting bias and the introduction of mandatory registries would enable more accurate monitoring across the region.

## Keywords

Africa, sub-Saharan, registry, total hip replacement, THR, total knee replacement, TKR

## Introduction

There are many patients in sub-Saharan Africa (SSA) suffering from conditions that may benefit from total joint replacement (TJR). However, these countries commonly do not have adequate resources to offer this service to all eligible patients.<sup>1</sup> TJR of the hip and knee is performed frequently in high-income countries and evidence supports that these procedures are cost-effective.<sup>2</sup>

Little is known about the outcomes or the number of TJRs performed in SSA. The age of patients and their indications for TJR differ considerably from those in the developed world and include a larger proportion of patients living with HIV.<sup>3,4</sup> Facilities, resources and training of surgeons and allied health professionals are substantially different from those of a high-income country.<sup>5</sup> It cannot be assumed that outcomes as seen on TJR registries, such as the UK National Joint Registry, will directly transpose to SSA.<sup>4</sup>

The cost of TJR is significant; costs in the USA are in the range of US\$16,000–60,000 for the procedure alone, depending on the institution.<sup>6</sup> In the UK National Health Service, where prices are dictated more by true cost than profit, total knee replacements (TKR) and total hip replacements (THR) are thought to cost approximately US\$7000–9000 per procedure.<sup>7</sup>

There are currently no systematic reviews in the literature investigating the outcomes of TJR in SSA. This review explores the literature surrounding outcomes of THR and TKR in SSA, including patient-reported outcome measures, evidence of complications, length of inpatient stay, inpatient mortality and revision rates.

<sup>1</sup>Registrar, Department of Trauma and Orthopaedics, Ninewells Hospital and Medical School, Dundee, UK

<sup>2</sup>Limb Reconstruction and Orthopaedic Trauma Fellow, Orthopaedic Research Unit, Department of Orthopaedic Surgery, Groote Schuur Hospital, Cape Town, South Africa

<sup>3</sup>Welcome Trust Clinical Research Fellow, Liverpool School of Tropical Medicine, Pembroke Place, Liverpool, UK

<sup>4</sup>Consultant Surgeon and Professor, Orthopaedic Research Unit, Department of Orthopaedic Surgery, Groote Schuur Hospital, Cape Town, South Africa

<sup>5</sup>Consultant Surgeon and Professor, Department of Trauma and Orthopaedics, Countess of Chester Hospital, Chester, UK

## Corresponding author:

Peter SE Davies, Department of Trauma and Orthopaedics, Ninewells Hospital and Medical School, James Arrott Drive, Dundee DD195Y, UK.  
Email: petersedavies@doctors.org.uk

**Table 1.** Inclusion and exclusion criteria.

Type of criteria	Description	Rationale
Inclusion	Short- or long-term outcomes of total knee or hip TJR	As per research question
	Performed in SSA	As per research question
	Studies produced in last 20 years	To maximise inclusion
Exclusion	Studies performed in South Africa	Outlier in terms of development
	Study not available in English	To minimise error

**Table 2.** MeSH headings.

Group 1 (OR)	AND	Group 2 (OR)
Total knee		Africa
TKR		Sub-Saharan
TJR		Poor country
Knee replacement		Developing country
Hip replacement		
THR		
Total hip		

## Methods

Scopus, EMBASE, Medline and PubMed databases were searched including papers published at any date up to and including 2018. Eligibility criteria are listed in Table 1. Papers from South Africa were excluded owing to the fact that the provision of healthcare and research resources are different to the majority of SSA.<sup>8</sup> South Africa is the second largest economy in SSA and although around 40% of the population live below the poverty line of ZAR 416 (about US\$35 per month), a large proportion of the population have access to private healthcare in line with that provided by Europe and North America.<sup>9</sup> This makes comparisons of the results of arthroplasty outcomes with the rest of SSA difficult.

Medical subject headings (MeSH) were combined using a Boolean strategy, using synonyms, alternate spellings and abbreviations, and are listed in Table 2. Eligible studies were backwards referenced to improve the search. Where papers were identified to duplicate reporting of earlier work, they were included with explanations provided.<sup>5,10–12</sup> The final search was undertaken on 4 November 2018. The preferred reporting items for systematic reviews and meta-analyses (PRISMA) process was followed (Figure 1).

## Results

Twelve papers were included and the results are displayed in Table 3.<sup>5,10–20</sup> Outcomes from 606 THRs

and 763 TKRs were reported from seven countries between 2009 and 2018. Three papers included results for both THR and TKR; for two of these, the results could be broken down into those for the two different procedures<sup>10,11</sup> but there was insufficient information in the third paper to do this.<sup>19</sup> Seven studies were performed using a prospectively collected database for data collection.<sup>5,10,12–14,16,17,20</sup> The remainder of studies were performed retrospectively.

### Patient demographics

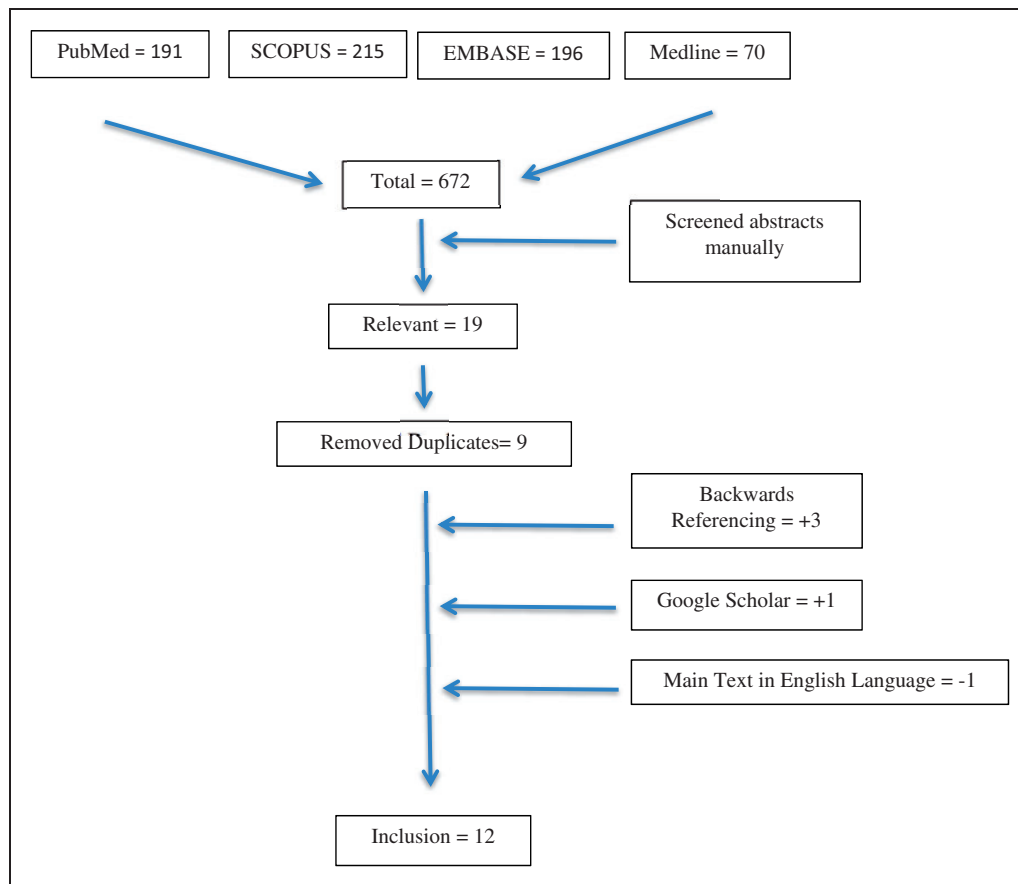
The median number of patients included in each paper was 58 (range = 8–313 patients). Patient demographics are included in Table 3 for each paper individually.

### Surgical methods

Researchers reported in varying detail about their surgical protocols. Laminar airflow was not used in any surgical centre, but DVT prophylaxis and perioperative antibiotics were used without exception. Patients were generally encouraged to mobilise full weight-bearing from day 1 or 2 postoperatively, except in one study where patients underwent bed-rest for one week.<sup>19</sup> Details of implant types and cementing techniques are given in Table 4.

### HIV-positive patients

Graham et al. reported on a cohort of patients with HIV undergoing THR, with excellent results. No complications were seen at a mean follow-up of 42 months.<sup>12</sup> A second paper by Graham et al. reported no complications in the nine HIV-positive patients undergoing TKR.<sup>13</sup> Data on HIV status were otherwise poorly reported. Lisenda et al. excluded all HIV-positive patients;<sup>11</sup> Lubega et al. tested 42 of 58 patients undergoing THR and found one-third were HIV-positive; and Mulla et al. tested only 12% of patients and found a similar prevalence.<sup>5,19</sup> No further papers reported on HIV status and no studies were designed to compare outcomes of patients living with HIV to healthy controls.



**Figure 1.** PRISMA diagram.

## Outcomes

Detailed outcomes are displayed in Table 3. Length of inpatient stay was reported in six papers and mean values were in the range of 7–14 days.<sup>5,10,13,14,16,20</sup> No information was provided in other papers. Inpatient mortality was well reported, with only one paper not specifically stating a value.<sup>15</sup> The overall rate in TKR was 0.9%,<sup>10,11,13,14,16,20</sup> while in THR it was 0.2%.<sup>5,10–12,17,18</sup>

Patients were followed up for various times (mean = 18 months; range = 0–149 months).<sup>10,12–16</sup> Incomplete data regarding follow-up were provided in four papers.<sup>11,17,19,20</sup> No data were provided in two papers.<sup>5,18</sup>

Six papers reported pre- and postoperative patient-reported outcome measures. Knee Society Scores (KSS) (range = 0–100) were shown to improve from 21.35 (range = 0–51) to 88 (range = 60–100);<sup>14</sup> Oxford Knee Scores (OKS) (range = 0–48 or 12–60) were quoted to improve from 15.5 (range = 4–24) to 44.5 (range = 35–59), 16.8 (range = 4–36) to 45.6 (range = 29–48) and from 12 to 45.5 (no ranges given).<sup>13,16,20</sup> Harris Hip Scores (HHS) (range = 0–100) improved from 29

(range = 9–50) to 85 (range = 79–91) and from 27 (range = 6–56) to 86 (range = 73–91) in two separate studies.<sup>5,12</sup> All papers described complications and all but three provided details of revision rates.<sup>10,14,19</sup> The mean deep infection rate for TKRs was 1.6% from all studies,<sup>11,13–16,20</sup> while for THRs it was 0.5% from all studies.<sup>5,11,12,17–19</sup> The dislocation rate for THRs was 1.6%.<sup>5,11,12,17–19</sup> Details of head sizes and approaches used are given in Table 5.

## Discussion

To the authors' knowledge, this is the first systematic review of TJR in SSA and there are many differences between the environment, patient cohort and healthcare provisions when performing TJR in SSA, compared to high-income countries.

### Model of healthcare in sub-Saharan Africa

Healthcare may be provided 'free at the point of use' and funded through taxation or through health insurance or self-payment.<sup>21</sup> Most high-income countries have a coexisting healthcare model where healthcare

**Table 3.** Studies of arthroplasty in sub-Saharan Africa.

Author (date)	Country	GNIPC (US\$)	Patients (n) (bilateral)	Age (years) (range)	Sex	Indication	HIV (% on HAART)	Mean CD4 cells/mm <sup>3</sup> (range)	Mean length of stay (days) (range)	Inpatient mortality (%)	Mean follow-up (months) (range)	Mean preoperative outcome measure (range)	Mean postop outcome measure (range)	Complications	Revisions (%)
<i>TKR</i>															
Katchy et al. <sup>20</sup> (2018)	Nigeria	5750	52 (16)	63.5 (55–77)	32 F 20 M	100% OA	No data		All over 14 days (no range)	1.9	No mean* (min 12)	OKS 12 (no range)	OKS 45.5 (no range)	1.9% superficial infection 1.9% foot drop 1.9% varus malalignment 1.9% stroke	1.9
Graham et al. <sup>13</sup> (2018)	Malawi	320	127 (26)	65.3 (24–84)	98 F 29 M	99% OA <1% AVN <1% RA <1% Sickle cell	6	No data	8.2 (5–20)	0	51 (6–126)	OKS 16.81 (4–36)	OKS 45.61 (29–48)	0.7% aseptic loosening 2.0% deep infection	2.6
Anyaeie et al. <sup>14</sup> (2017)	Nigeria	5750	38 (7)	62.6 (41–85)	7 M 31 F	76% OA 20% PTOA 4% Post surgery	No data		Min 14	0	32 (13–52)	KSS 21.35 (0–51)	KSS 88 (60–100)	8.9% common per nerve palsy 4.4% superficial infection 2.2% sacral sore 2.2% fracture 2.2% deep infection	No data
Lisenda et al. <sup>10</sup> (2016)	Botswana	16710	170 (23)	64.5* (26–86)	34 M 159 F	98% OA 2% RA	No data		7* (4–21)	2	0	No data	No data	0.7% pulmonary embolism	No data
Lisenda et al. <sup>11</sup> (2016)	Botswana	16710	51 (7)	65.6 (46–81)	5 M 53 F	92% OA 8% RA	0	All excluded	No data	3	No mean (26–47)*	No data	No data	1.7% deep infection 1.7% dislocation	1.7
Kigera and Kimpiatu <sup>15</sup> (2015)	Kenya	1380	231	67.3	M:F 1:3	96% OA	No data		No data	No data	16 (0–149)	No data	No data	3.9% superficial infection 2.6% deep infection	2.6
George and Ofori-Atta <sup>16</sup> (2009)	Ghana	4160	7 (1)	59.3 (38–71)	6 F 1 M	88% OA 12% PTOA	No data		10 (5–12)	0	6 (3–12)	OKS 15.5 (4–24)	OKS 44.5 (35–59)	12.5% loosening	12.5
<i>THR</i>															
Lisenda et al. <sup>10</sup> (2016)	Botswana	16710	143 (10)	64.5* (26–86)	98 M 55 F	64% OA 31% AVN 3% DDH 2% RA	No data		7* (4–21)	0	0	No data	No data	0	No data
Lisenda et al. <sup>11</sup> (2016)	Botswana	16710	41 (1)	66.2 (43–86)	25 M 17 F	76% OA 22% AVN 2% TB	0	All excluded	No data	0	No mean (26–47)*	No data	No data	2.4% dislocation	0
Dossche et al. <sup>17</sup> (2014)	Burkina Faso	1730	136 (16)	49 (21–78)	86 M 53 F	40% AVN 37% OA 23% Fracture	No data		No data	1	Min 6–8	No data	No data	11.2% fracture 0.7% femoral nerve palsy 0.7% burn 1.3% haemolysis 0.7% PE 1.3% dislocation	6.6

(continued)

Table 3. Continued

Author (date)	Country	GNIPC (US\$)	Patients (n) (bilateral)	Age (years) (range)	Sex	Indication	HIV (% on HAART)	Mean CD4 cells/mm <sup>3</sup> (range)	Mean length of stay (days) (range)	Inpatient mortality (%)	Mean follow-up (months) (range)	Mean preoperative outcome measure (range)	Mean postop outcome measure (range)	Complications	Revisions (%)
Graham et al. <sup>12</sup> (2014)	Malawi	320	29 (14)	47 (21–59)	19 M 10 F	80% AVN 6.5% AVN 6.5% Post TB 4% NOF 2% Perthes	100 (100)	489 (183–1017)	No data	0	42 (6–98)	HHS 27 (5–56)	HHS 86 (73–91)	0	0
Kingori and Gakuu <sup>18</sup> (2010)	Kenya	1380	97 (2)	No data	No data	No data	No data	No data	No data	0	No data	No data	No data	2.0% dislocation 2.0% superficial infection 2.0% fracture 2.0% DVT 1.0% deep infection 1.0% upper GI bleed 1.0% haematoma 1.0% sciatic nerve palsy	1.0
Lubega et al. <sup>5</sup> (2009)	Malawi	320	58 (15)	52 (18–73)	33 M 25 F	49% AVN 30% OA 10% Fracture 4% Malunion 3% Perthes 1% GCT 1% TB	33 positive 58 tested	543 (183–1410)	10 (7–19)	0	No data	HHS 29 (9–59)	HHS 85 (79–91)	2.7% dislocation 1.4% pulmonary embolism 1.4% aseptic loosening	1.4
Combined Mulla et al. <sup>19</sup> (2010)	Zambia	3850	TKR 7 THR 43 Rev THR 1	58.4* (23–82)	21 M* 31 F	71% OA* 14% AVN 4% RA 6% Fracture 2% Failed THR 2% DDH 2% Post TB	33 positive* 12 tested	No data	No data	TKR 0 THR 0	Min 1*	No data	No data	TKR 0 THR 7.0% dislocation 4.7% infection	No data

\*TKR and THR data combined.

**Table 4.** Details of implants and cementing techniques used.

Author (date)	Implant details	Cementing details
<i>TKR</i>		
Katchy et al. <sup>20</sup> (2018)	68 DePuy Biomet PS	No data
Graham et al. <sup>13</sup> (2018)	171 DePuy CR PFC 2 DePuy CS PFC 4 Biomet AGC	All Smartset GHV
Anyaehe et al. <sup>14</sup> (2017)	All Johnson and Johnson PFC Sigma	All Palacos
Lisenda et al. <sup>10</sup> (2016)	No data	145 cemented 42 hybrid 6 uncemented
Lisenda et al. <sup>11</sup> (2016)	Smith and Nephew Profix	26 cemented 26 hybrid 6 uncemented
Kigera and Kimpiatu <sup>15</sup> (2015)	81 DePuy 12 Zimmer	All cemented 2 g Gentamicin in 40 g cement
George and Ofori-Atta <sup>16</sup> (2009)	No Data	No data
<i>THR</i>		
Lisenda et al. <sup>10</sup> (2016)	No data	147 uncemented 6 hybrid
Lisenda et al. <sup>11</sup> (2016)	41 Smith and Nephew porous synergy 1 Spectron Hip 15 Reflection Spiked Acetabulum 27 R3 Acetabulum	All uncemented
Dossche et al. <sup>17</sup> (2014)	141 Charnley or Kheos 3 Vives Femur	All femurs cemented 5 uncemented acetabulum 147 cemented acetabulum
Graham et al. <sup>12</sup> (2014)	45 Charnley and Ogee 3 Biomet Stanmore	All Smartset GHV
Kingori and Gakuu <sup>18</sup> (2010)	No data	All cemented
Lubega et al. <sup>5</sup> (2009)	43 Charnley and Ogee 29 Biomet Stanmore	All Smartset GHV
<i>Combined</i>		
Mulla et al. <sup>19</sup> (2010)	No data	No data

**Table 5.** Head sizes and approaches used in THRs.

Author (date)	Dislocation rate (%)	Mean follow-up (months) (range)	Head sizes (mm)	Head size (dislocated) (mm)	Approaches used (%)
<i>THR</i>					
Lisenda et al. <sup>10</sup> (2016)	0	0	No data	N/A	Anterolateral 100
Lisenda et al. <sup>11</sup> (2016)	2.4	No mean (26–47)	36 (57.1%) 32 (4.8%) 28 (38.1%)	28 (100%)	Anterolateral 100
Dossche et al. <sup>17</sup> (2014)	1.3	Min 6–8	No data	No data	Anterolateral 100
Graham et al. <sup>12</sup> (2014)	0	42 (6–98)	Insufficient data	N/A	No data
Kingori and Gakuu <sup>18</sup> (2010)	1	No data	No data	No data	Anterolateral 95 Posterior 5
Lubega et al. <sup>5</sup> (2009)	1.4	No data	Insufficient data	No data	No data
<i>Combined</i>					
Mulla et al. <sup>19</sup> (2010)	7	Min 1	28 (51.6%) Missing data in 48.4%	No data	Hardinge 84.3



insurance is available to those who can afford it, with a state-run safety net for those who cannot. Examples of both types of healthcare are found in SSA, but each comes with its own limitations in these populations. Nigeria, for example, has historically had no healthcare insurer.<sup>14</sup> Different countries within SSA have hugely variable economic circumstances, as demonstrated in Table 3.<sup>22</sup> The gross national income per capita is US\$16,710 in Botswana but only US\$320 in Malawi.<sup>22</sup> Average government spending on healthcare across SSA has been reported as US\$90 (range = US\$14–663) per year per person, which compares to a typical value of >US\$5200 in high-income countries.<sup>23,24</sup>

Several institutes in SSA work in collaboration with experienced high-volume TJR surgeons from high-income countries, who visit them temporarily to perform surgery.<sup>10,11,17</sup> This has the benefit of training locally based surgeons to become independent arthroplasty surgeons in areas where this training is otherwise not available. However, one of the main drawbacks of using visiting surgeons is continuity of care and that these surgeons are unlikely to be available to follow up the patient if they develop a complication requiring further surgery.

From our experience, we believe the best provision of any arthroplasty service is by a local multidisciplinary arthroplasty team. This team can benefit from input from international support if the appropriate training and experience is not initially established but should aim to become self-governing. An example of this approach is the Malawi National Joint Registry.<sup>5,12,13</sup>

### *Differences in patient demographics in sub-Saharan Africa*

In SSA, the adult prevalence of HIV in 2013 was approximately 4.7%, compared with 0.3% in Europe and North America.<sup>3</sup> Within SSA, prevalence estimates also vary between countries; for example, in 2013 the estimates for Malawi and Botswana were 21.9% and 10.3%, respectively.<sup>3</sup> Only five of our papers documented HIV status.<sup>5,11–13,19</sup> Graham et al. demonstrated no increased risk of complications in HIV-positive patients undergoing THR, including infection.<sup>12</sup> However, no other papers reported outcomes related to HIV-positive patients undergoing TJR.

In patients from SSA, avascular necrosis was a frequent indication for THR and has previously been associated with HIV infection.<sup>25</sup> Lubega et al. found 49% of patients in their study had avascular necrosis and, of these, 44% had HIV.<sup>5</sup> Mulla et al. did not find such a high rate of avascular necrosis (14%) but acknowledged they did not have magnetic resonance imaging facilities and may have attributed painful hips to osteoarthritis without further consideration.<sup>19</sup>

Patients were younger than those seen with osteoarthritis in high-income countries, which may indicate an increased prevalence of avascular necrosis than that which was reported. Mulla et al. found a higher rate of dislocation at 3.9% and suggested several cultural reasons.<sup>19</sup> Patients often use squat toilets and kneel for prayer, requiring deep hip flexion, which contradicts routine THR precautions. Patients may also be manual workers, e.g. farmers, and need to work as soon as possible after their surgery, owing to minimal social support. Patients' occupations were not reported in any study, so conclusions may not be drawn.

### *Outcomes of surgery in sub-Saharan Africa*

Use of laminar flow is rare in SSA but has been standard for TJR in high-income countries since it was introduced by Sir John Charnley in the 1970s.<sup>26</sup> However, its necessity has recently been questioned.<sup>27</sup> An underlying diagnosis of avascular necrosis has previously been linked to increased risk of infection, 90-day mortality, readmission and revision, in some studies.<sup>28,29</sup> Overall infection rates in SSA appeared satisfactory, as demonstrated in Table 3.

The observed improvement in mean OKS was a greater increase than typically seen in high-income countries.<sup>16</sup> The 2013 report of the UK National Joint Registry presented an average increase from 19 to 26.<sup>30</sup> An improvement in mean KSS was reported and data from a high-income country have shown smaller improvements in KSS from 53 to 80.<sup>14,31</sup> Allowing for some natural decline in function with 3–6 years of extra follow-up in the high-income group, these data are still likely to represent a similar if not superior improvement in function in the SSA paper.<sup>14</sup> Improvements in HHS from 29 to 85 were noted.<sup>5</sup> This compares with data from a high-income country, showing improvement from 43 to 87.<sup>32</sup> Again, inferior preoperative scores were noted in SSA, indicating that patients are more likely to have advanced disease and may stand to benefit more from TJR than patients in high-income countries, who are likely to present earlier for treatment.

### *Joint registries in sub-Saharan Africa*

Malawi is the only country in SSA to have a dedicated national joint registry.<sup>5,12,13</sup> The majority of the data from SSA was collected using local prospective databases.<sup>10,11,14,16,17,19</sup> Reported study size varied but was generally small. This compares with the most recent report on the UK National Joint Registry, which included 2.35 million records.<sup>4</sup> The first country to develop a national orthopaedic registry to determine outcomes of TJR was Sweden in 1975.<sup>33</sup> Since then,



many high-income countries have developed similar programmes. The benefits of national registries are many and include eliminating reporting bias, allowing comparison between units, and early identification of problem implants and techniques.

### Follow-up

There are several limitations to the follow-up process in SSA. Patients may have to travel large distances to attend follow-up, with significant time or cost investment to do so. In a study from Kenya, Kingori and Gakuu found 34% loss to follow-up at six months.<sup>18</sup> However, with investment in a dedicated TJR follow-up clinic and dedicated nurse, as well as provision of outreach clinics, Lisenda et al. were able to maintain 100% follow-up.<sup>11</sup> Improvement in follow-up is likely with increasing access to mobile phones and reminders through this method have been shown to work well in antiretroviral therapy programmes.<sup>34</sup>

### Limitations

There is likely to be a profound reporting bias in studies from SSA with only those centres with good results publishing their outcomes. Centres with poor results would probably choose not to do so. The only way to avoid this is to introduce mandatory national registries that would eliminate this bias. This would also increase the number of patients reported on and thus give more reliable data.

Two papers duplicated follow-up of earlier papers.<sup>10,12</sup> Graham et al. reported from the same database as the previous Lubega et al. paper but specifically looked only at patients with HIV and therefore it was useful to include this paper.<sup>5,12</sup> Lisenda et al. published two papers, one of which looked only at the inpatient period of care.<sup>10,11</sup> This included a larger cohort of patients but is likely to have duplicated some reporting. It was impossible to identify the significance of this from the manuscripts.

The overall outcomes of TJR surgery in SSA are positive; however, it must be noted that the patient population reported on, of predominantly self-paying patients, is likely to be healthy, well-nourished and well supported socially. Surgery is also likely to be performed in private well-funded hospitals. The included studies are not likely to represent results of the general population undergoing surgery in government hospitals. If it were financially possible to extend TJR across all population groups, it may be found that complication rates and outcomes vary. Implementation of mandatory national registries would ensure transparency of outcomes and allow appropriate targeting of resources and training.

This research only included studies that were published in the English language and as a result, relevant

studies published in other languages are likely to have been missed.

## Conclusions

Overall, positive results were reported from TJRs in SSA, with comparable rates of complications to those reported in high-income countries. However, there is likely to be significant reporting bias, and the introduction of national and regional joint registries would have the benefit of allowing more accurate monitoring of outcomes.

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### ORCID iD

Peter SE Davies  <http://orcid.org/0000-0002-4367-7439>

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